

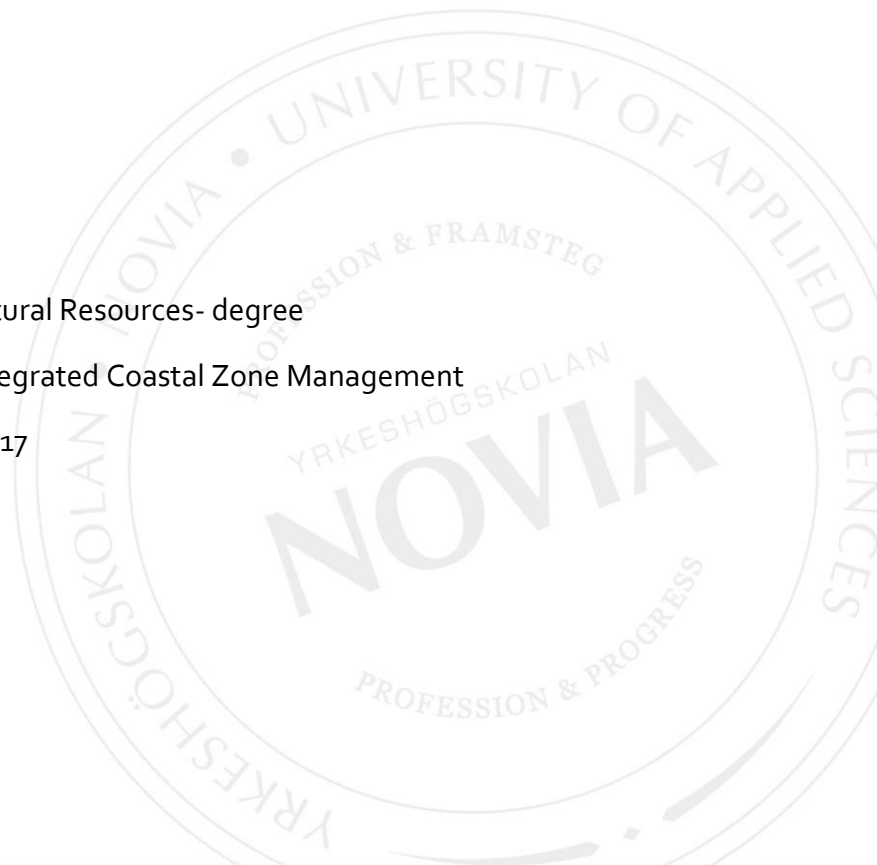
Artificial turf field and environment

Jenni Möller

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EXAMENSARBETE

Författare: Jenni Möller

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Handledare: Anna Granberg

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Abstrakt

Konstgräsplaner blir allt populärare i fotboll och dom börjar ersätta vanliga gräsplaner. När man gör nya fotbollsplan väljer man allt oftare konstgräset som underlag. Man tycker att konstgräsplaner är skötselfria och tåligare jämfört med vanliga gräsplaner. Speciellt på torra områden var det finns brist på vatten blir konstgräsplaner populärare. Också i norra delen av kloten blir konstgräsplaner populärare för att den gör tränings- och spelsäsongen längre. Konstgräsplanen är mera ekonomiskt än gräsplan i långa loppet. Båda ytor har dock sina fördelar och nackdelar.

I det här slutarbetet kommer jag att jämföra båda spelytor av miljöns synvinkel och kommer att berätta om möjliga miljöpåverkan. I tillägg till detta kommer jag att sortera stora stadionernas miljöpåverkan och hur kan man få det mindre.

Går också igenom möjliga hälsopåverkor av konstgräsplaner. Det har på sistone varit mycket prat om gummigranulernas möjliga hälsorisker. Gummigranuler som är gjort av återvända bildäckar innehåller bland annat cancerframkallande och endokrina störande föreningar. SWOT-analysen hjälper läsaren att förstå olikheter av planytor och deras fördelar och nackdelar.

Språk: Engelska

Nyckelord: konstgräs, naturgräs, miljö, fotboll

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Tekijä: Jenni Möller

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Liitteet

Keinonurmikentät yleistyvät kovaa vauhtia ja ne alkavat jo syrjäyttämään luonnonnurmikenttiä jalkapallossa. Uusia jalkapallokenttiä tehdessä valitaan yhä useammin keinonurmikenttä. Keinonurmia pidetään huoltovapaina ja luonnonnurmea kestävämpänä pelialustana. Varsinkin kuivilla alueilla missä vedestä on pulaa, on keinonurmikenttä houkutteleva vaihtoehto. Myös pohjoisella pallonpuoliskolla keinonurmikentät ovat suosittuja niiden tarjoaman pidemmän pelikauden ansiosta. Lisäksi keinonurmikenttä on pidemmällä aikavälillä luonnonnurmea taloudellisempi valinta. Molemmilla pelialustoilla on sekä hyvät että huonot puolet.

Tässä lopputyössä vertailen molempia pelialustoja keskenään ympäristön näkökulmasta sekä näiden kenttien mahdollisia ympäristövaikutuksia. Tämän lisäksi selvitän erikseen isojen stadioneiden mahdollisia ympäristövaikutuksia sekä miten niitä on mahdollista saada pienemmiksi.

Käyn myös läpi keinonurmikenttien mahdollisia terveyshaittoja. Keinonurmikentillä käytetty kumirouhe on ollut viime aikoina esillä sen terveyshaittojen takia.

Kierrätysmateriaaleista tehdyn kumirouheen on tutkittu sisältävän muun muassa syöpää aiheuttavia sekä hormonitoimintaa häiritseviä yhdisteitä.

SWOT-analyysi auttaa lukijaa ymmärtämään kenttien välisiä eroja sekä niiden vahvuuksia että heikkouksia.

Kieli: Englanti

Avainsanat: keinonurmi, luonnonnurmi, ympäristö, jalkapallo

BACHELOR'S THESIS

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Appendices

Abstract

The artificial turf fields are getting more and more popular and they are starting to supersede natural grass fields in football. When building new football fields the choice is today often artificial turf field. One reason for that is that artificial turf fields are thought to be maintenance free and more durable than artificial turf field. Especially in dry areas where there is a lack of water the artificial turf field is a good option. Also in the northern hemisphere, the artificial turf fields are popular today because they provide longer training season. In addition, the artificial turf field is more economical choice than natural grass field in the long run. Both of the fields have their pros and cons.

In this thesis I am going to compare both of the fields in an environmental aspect and also compare their environmental impacts. Besides that, I am going to find out the environmental impacts of big stadiums and also how to get the impact smaller.

The possible health issues are also taking into consideration. The rubber granules used in artificial turf fields have been researched to include carcinogenic and endocrine disruptive compounds. The SWOT-analysis helps the reader to understand the differences, pro and cons of the different field types.

Language: English

Key words: artificial turf field, natural grass field, environment, football

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1 Method

In this thesis I am going to research the possible environmental- and health issues around artificial turf fields and also map out some possible environmental risks. I am also going to compare the environmental issues between natural grass and artificial grass.

One part of this project is going to describe shortly the structure of 3rd generation artificial turf. There are older variations of the artificial turf but in this thesis this thesis is going to focus to the newest one i.e. the 3rd generation artificial turf. The effects of artificial turf fields to water bodies, vegetation and to the soil are going to be researched. I am also going to research the salt (sodium chloride, NaCl) used to melt the snow from the artificial turf fields as well as the different types of the rubber granules used in artificial turf. Some figures of the costs are important in order to get a good picture of the viability of the different field types.

One angle of this thesis is going to find out the possible health issues considering the artificial turf field and especially the rubber granules used in artificial turf field which has caused quite a debate in the USA and in Great Britain.

SWOT-analysis is made to both of the field types and for comparison tool and for helping to understand easily with a quick look the differences with these two different field types. The environmental impacts are quite different in a training field compared to a big stadium with a 100 000 people capacity and that is why I go through shortly the environmental impacts in a bigger scale in other words in big stadiums and in events such as FIFA world cup.

I am going to write about the environmental issued of big stadiums but overall this thesis is going to deal with regular football fields found in most of the cities around Finland. They are the fields most used and they create the majority of different football fields in Finland. We do not have that many big stadiums so I am going to go through the possible issues with stadiums in a separate chapter.

2 Theory

2.1 Background

Here is some statistics over how much does it cost to establish different types of football fields and also how much does the maintenance of them cost. Here the reader can get a good overlook of the economical differences of the different field types. (Finnish football association)

Investment costs for football fields

- natural grass field 175 000-200 000€
- natural grass field with heating system approx. 300 000€
- artificial turf field approx. 460 000€
- artificial turf field with heating system approx. 560 000€

Maintenance and upkeep

- natural grass field approx. 9000€/year
- natural grass field with heating system approx. 19 000€/year
- artificial turf field approx. 3000€/year
- artificial turf field with heating system approx. 50 000€/year

Operating hours

- natural grass field, May-September, approx. 20 weeks – 12h/week – 240h/year
- natural grass with heating system, April-September, approx. 22 weeks – 12h/week – 264h/year
- artificial turf field, March-November/December, approx. 45 weeks – 50h/week – 2250h/year
- artificial turf field with heating system, year around, approx. 52 weeks – 50h/week – 2600h/year

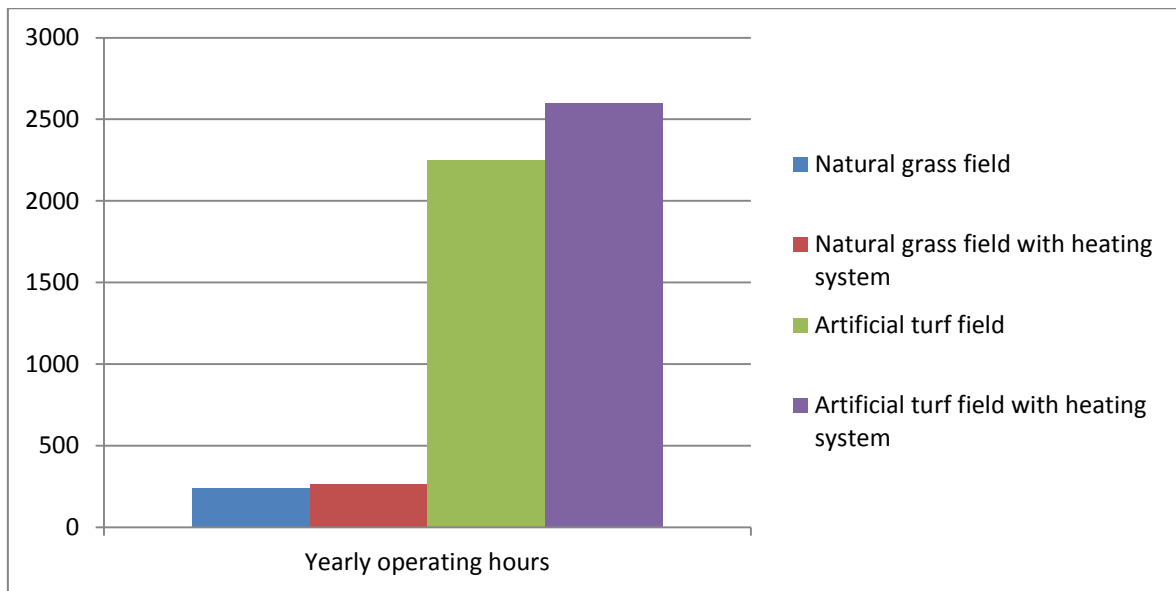


Figure 1: yearly operating hours

Figure 1 shows the yearly operating hours in different field types with and without the heating system. It gives a good overview of the differences between field types.

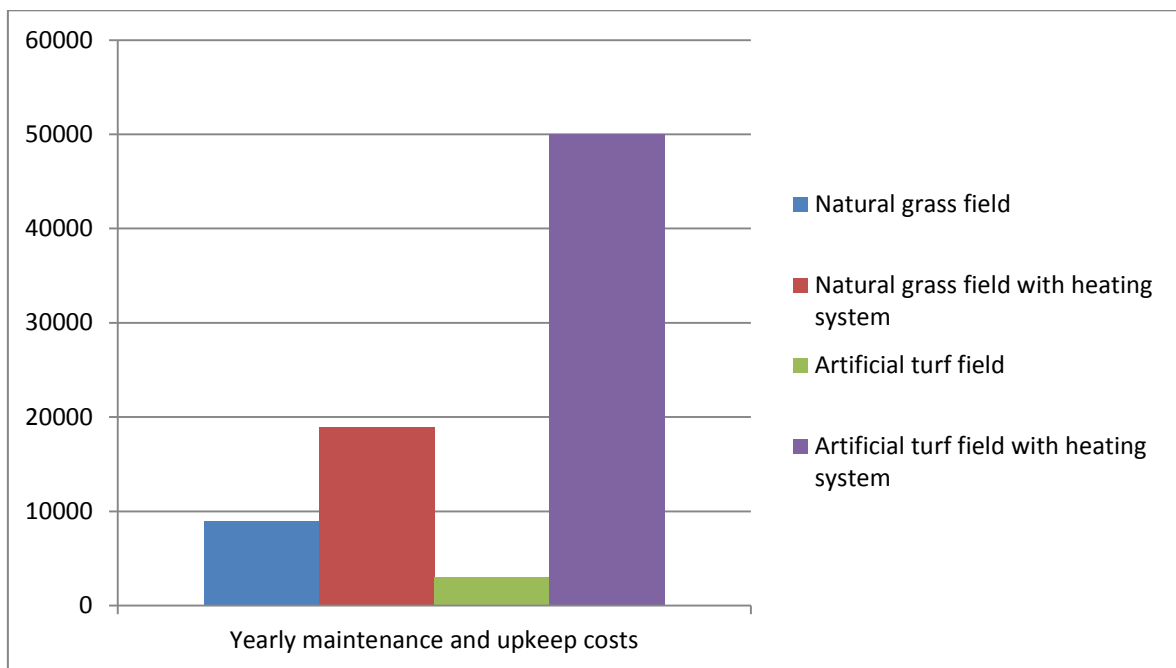


Figure 2: yearly maintenance and upkeep costs

Figure 2 shows the yearly costs of maintaining different types of football fields. The upkeep cost of the heated artificial turf field gets so high because of the year around usage. Heating is on several months of the year and also lightning of the field is on much more hours than in any other field types. Those two things are the main reasons for the significant bigger amount of costs.

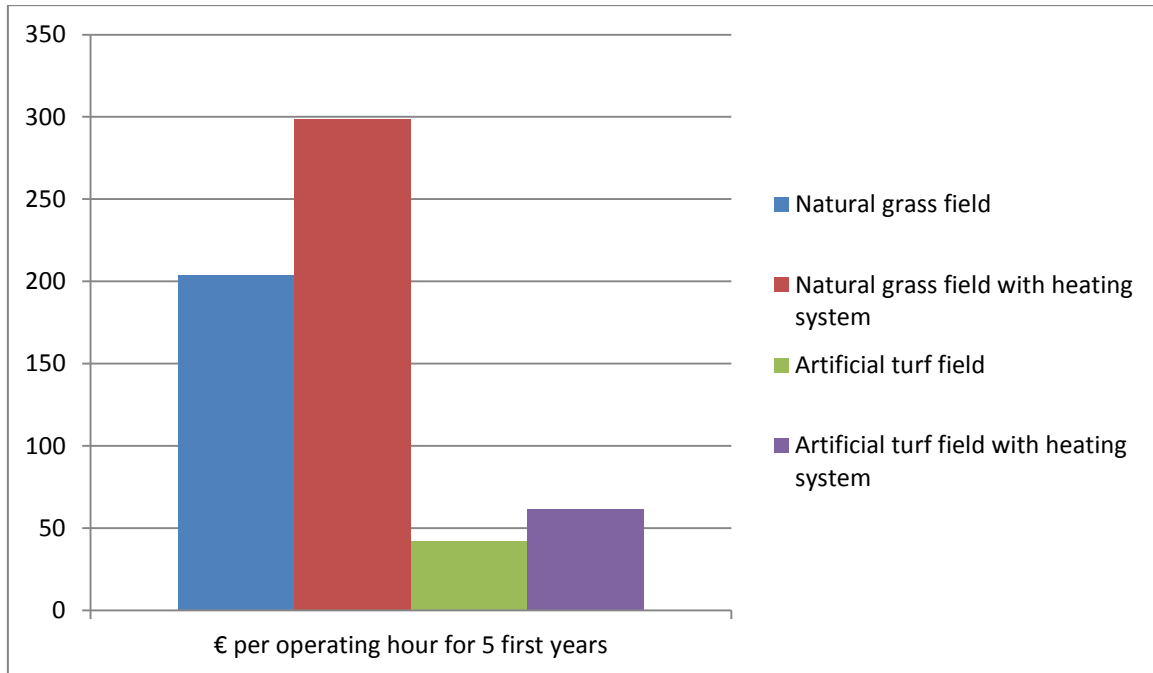


Figure 3: euros per operating hour for the 5 first years.

Figure 3 shows the price for one operating hour in a certain field type. The calculation includes the investment costs and maintenance cost for 5 years. Then the costs have been divided by the operating hours for 5 years.

- Natural grass 204€/ hour
- Natural grass with heating system 299€/ hour
- Artificial turf field 42€/ hour
- Artificial turf field with heating system 62€/ hour

2.2 Structure of the artificial turf field

The artificial turf fields can be separated into three different groups: 1st generation artificial turf, 2nd generation artificial turf and 3rd generation artificial turf. (Suomen Palloliitto, 2011) The 1st generation artificial turf fields are the first ones that came on the market and they used to be covered with sand instead of the rubber granules. The very first synthetic field was built in 1964 to Rhode Island, New York. In 1976 the synthetic surface was introduced for Olympics in the Montreal summer Olympic Games. Then the first sport played on the synthetic field was hockey. The 1st generation surface used to be really hard and they used to be quite burdensome for the human body. Artificial turf fields today, the

3rd generation, are really close, or even better, compared to the natural grass fields in terms of the game features and evenness. Especially the uniform surface and the durability of the weather and usage speak of the behalf of the artificial turf fields.

In 2000 Finnish Football Association accepted the artificial turf field as a official surface in all the leagues.

FIFA is also testing all the competitive artificial turf fields to keep all the fields uniform.

The FIFA quality concept was released in 2001. (FIFA, 2001)

The structure of the 3rd generation artificial turf football field is in outline like this from the bottom to the surface: (Suomen Palloliitto, 2011)

- **primer**, *same principles as when building roads*
- **drain**, *similar as in the natural grass fields*
- **heating pipes**, *this is not installed in every field because of the costs. The heating can be done either with electricity or liquid circulation*
- **irrigation system**, *recommended to minimize the friction. Only used in the bigger stadiums.*
- **the flexible layer**, *a special flexible mat under the surface. In Finland usually used only in fields in bigger stadiums*
- **fabric**, *the pile threads are sewn up to this. The fabric can be made out of different materials but it is usually strengthen with latex. The fabric need to let the water run through so there are special holes for that.*
- **pile thread**, *height 40-70mm*
 - *Pile thread is one of the most important factors affecting the quality of the artificial turf field. It is also the main factor of how long the field lasts playable and in proper condition. There are a many different variations of the materials and lengths of the pile thread but the most common material used for them is nowadays polyethylene almost in every case. The pile thread can be either fibrillated or monofilament. Pile thread is the material on the artificial turf field which make the feeling of playing on the natural grass. That's why it is important that the pile thread is good quality and that it stays up*
- **filler**, *grain size 0,5-2mm*
 - *In Finland the rubber granules are most commonly used filler material. They are made from recycled materials, such as car tires. The SBR-granules are used commonly because of the cheap price and their technical features. In some artificial turf fields there are used natural rubber granules or thermoplastic elastomer but they are much more expensive to use than the SBR-granules and that's why they are not that common. It is estimated that*

one artificial turf field uses approx. 27 000 car tyres for the rubber granules. When installed there needs to be a 15mm thick layer of rubber granules. And when the granules are carried away from the field the amount of the granules needs to be increased.

All factors mentioned above effects the game and how the ball behaves on the field and how the field burdens the body of the player. The biggest impacts to the game are the amount of the filler and its evenness on the field, the pile thread and its quality and then the possible flexible layer.

International football association, FIFA, has determined the quality requirement for artificial turf field (FIFA, Quality concept for football turf) and they are using precise measurements and tests. In Finland for example all the artificial turf fields used in the highest league are tested yearly. The tests consist of different player-field and ball-field interaction tests but it does not take the environmental issues into consideration. (Suomen Palloliitto, 2011)

2.3 Rubber granules

Approx. 25000-30000 car tyres are needed to make rubber granules for one standard sized artificial grass field. The amount depends of course of the size of the field. As the time goes by the granules are carried away from the field with the users so there needs to be brought more rubber granules at a regular basis. Researches have been showing that the SBR-rubber granules made out of recycled car tyres are containing among other things these metals: (Turfgrass resource center: Natural Grass and Artificial Turf: Separating Myths and Facts) (Kemikalieinspektionen, 2006)

- aluminium (Al)
- cadmium (Cd)
- chromium (Cr)
- copper (Cu)
- sulphur (S)
- lead (Pb)

The SBR-rubber granules are most commonly used in Finland. It is made from recycled car- or truck tyres. Also leftover rubber, such as sealant and pipes, from the industry are used. Usually the tyres are washed properly and the metals and fibres are removed from the

tyre. After that the tyres are grained to small granules. It is good that materials used are recycled as much, as efficiently and as often as possible. The down side of recycling is that the product is taken to a whole new environment and we change the usage of the product. Like in this case where rubber from car tyres are brought to sports- and playfields. Same time we are recycling materials we are also spreading chemicals to a new environment and exposing to them differently. The manufactures of the rubber granules claims that the material is safe and there is no health risk in the usage of the recycled car tyres. Car tyres contains among other things carcinogenic compounds, PAH-compounds (polycyclic aromatic hydrocarbon) and endocrine disruptive chemicals. (Yle, 2017). They are hard and expensive to remove from the material so some amounts are transferred to sports fields and playgrounds. Besides the health issues there are some other negative sides of the usage of the SBR- rubber granules. The granules are easy flammable so for example smoking is highly forbidden in artificial turf field. The granules can be made fire retardant but that costs extra money. Even though the SBR-rubber granules can tolerate the UV-radiation really well they absorb heat really well so during summer the temperature of the granules can be between 40-50 °C. Even though the SBR- rubber granules is the most common filling used in Finland, the Finnish Football Association does not recommend to use them as a filling material.

Finnish Football Association recommend the usage the thermoplastic elastomere in artificial turf fields and especially in indoor fields. It does not heaten up in the sun, it can be re-use or melt to new purposes, it does not include any harmful components and it is not flammable. Only problem for the usage of the thermoplastic elastomere granules is the high price of them.

3 Common environmental issues

3.1 The construction of sports fields

Already during the planning phase the constructor has to take into consideration the possible environmental issues the new sports field is going to have. Often the big sports field modifies the landscape quite much so the location of the sports field is important and has a big role. The selection of the place where to build can also save a lot of money in the building phase. For example an old sand plan is a great place to build an artificial turf field.

If the field is built close to schools or kindergartens the kids can utilize the field also.

While planning a new field the planner has to take into consideration the topography of the area, possible surface water areas, trees and vegetation. The field needs to be high enough so that the surface waters do not run to the field. The gradient of the field should be between 0.5-1% so that the rain water runs off the field properly. There is no requirement to do environmental impact assessment (EIA) to this kind of project. The primer needs to be done carefully in order to avoiding the problems that frost can do to the field. If the primer is not properly done the frost might cause big damage to the field such as making the field uneven and bumpy.

Many factors during the construction affect the ecological factors of the area, such as excavation and the drainage works of the area. The changes in the ecology are often quite slow so the perceptions of the changes can take even years after the sports field is ready. Terrain design is really important during the construction phase and with the help of that surface water can be steered, shelter from the wind can be made as well as vision- and noise barrier can be made. ⁶ Opetusministeriö, Jaakko Pöyry Infra, *Urheilukenttien suunnittelu- ja rakentamisopas*, Rakennustieto OY 2002. Usually there is a fence so that the balls do not run from the field and cause any danger for example for the traffic.

In terms of recycling and energy efficiency it is justified to use recycled materials, such as the recycled car tires.

The traffic solution needs to take also into consideration in the building phase. Enough parking place for cars and possible public transportation connections. Many of the users are youngsters or kids so a safe pedestrian road is important.

3.2 Water bodies

Sodium chloride, which is used in the melting of the artificial turf field and its chloride ions does not absorb in large quantities to the soil but they are easily carried to the ground- and soil waters which are complex ecosystems. That does not affect much to the water quality because the concentration dissolves to the water quickly. The sodium chloride which is spread to the artificial turf field does not spread to the environment almost at all. Only when ploughing the snow from the artificial turf field the sodium chloride can be spread, depending where the snow is ploughed. With a good drainage close to the field, the spreading can be prevented even though the snow is moved from the field.

There are also some natural “chemicals” to melt the snow from artificial turf field but they cost several times more than the sodium chloride. Groundwater can be used to melt the field also but that requires that the pipes and melting system are installed in the building face under the artificial turf field. (Suomen ympäristökeskus, 2007)

With the help of rainwater and melting water nanoparticles are carried away from the artificial turf field. The granules are also carried away from the field by the players. They get stuck to clothes, bags and hair and are transferred elsewhere. At the end the nanoparticles end up to organisms living in the water and in the soil, to groundwater and to the sea. Even though the environmental impacts are quite local there has been a research in Sweden where the researchers have found residues of rubber granules used in artificial turf field in fishes. Artificial turf field does not absorb rainwater like natural grass field does, but with good drainage the leakage of fine materials and water can be controlled. The PAH- compound used in rubber granules does not dissolve in water and instead they are really permanent and end up easily to the soil and sink to the sediments in waterbodies. (U.S. Department of health and human services 1995)

3.3 Vegetation

The vegetation suffers at the construction face when making the sports field. Trees need to be cut and soil needs to be dug up which might destroy the roots of trees close by. The usage of sodium chloride causes for example wither of needles and leaves and premature fall. The effect of the sodium chloride is bigger through the air than through the roots. (K. Kankaanpää, 2015)

For easier maintenance of the artificial turf field it is important that there are not big trees or bushes directly close to the field. The fallen leaves and needles on the field need to be taken away. Otherwise the sports field itself does not affect the surrounding vegetation. (Football Foundation)

3.4 Soil

A large amount of sodium chloride can effect negatively to water permeability. That's because sodium ions dissolve the suspension particles. Sodium chloride might also effect negatively to the amount of calcium and magnesium in the soil because of the increased alkalinity. (K. Kankaanpää, 2015)

It is not though likely that a large amount of sodium chloride would end up into the soil

from artificial turf fields because of the amounts used to de-ice the field and also because of the drainage on the area. The snow piles are ploughed to certain areas where the sodium chloride ends up in the drainage with the melting water.

3.5 Waste

The waste management of the fields is quite small scaled. The waste needs to be collected from the locker rooms and from the stands. The amount of the waste is not much in an average training field. The possible chemicals and fertilizers needs to be sorted out correctly and the grass from mowing can be composted.

In stadiums biggest amount of waste comes from the public. In big stadiums where there can be over 100 000 fans watching a game it is extra important to provide a possibility to recycle. Biggest amount of waste comes from food and drinks.

3.6 Noise

The noise coming from the fields is local and only on special times. It is possible to minimize the noise with the structions and landscaping but in cities the areas for fields are quite small so it is not possible to build big structures to keep the noise. The machinery used for maintenance can cause some noise but it should not affect any neighbours. Most of the noise comes from match day when there is music and audience.

3.7 Traffic

It is important to build roads that the traffic flows smoothly to and from the field especially if the fields are used to play league games with a large audience expectation. For big stadiums it would be best to create a public transport system which would encourage people to leave their car home and take a bus, train or subway instead. Also the parking solutions need to be taken into consideration and reserve enough parking spaces. All the public transport vehicles such as busses should be function with renewable energy. The public transportation needs to work smoothly and be planned around the game times so

that it would entice the audience to use it. The smoother the public transportation works the more people want to use it.

3.8 Lighting

All the fields are not lighted in Finland but specially artificial turf fields need to have lights in order to be able to use them year around. In official games the lightning need to be minimum of 00 LUX and in national games the minimum is 1200 LUX. (Sähkötietyö ry 2004) The lamps need to fill requirements for brightness and frequency. The bright light can disturb if there are people living next to the field if it does not have any stands to prevent the light pollution. That's why it is important to direct the light correctly so that the light pollution would be as small as possible. The lights constitute usually the biggest part of the electrical consumption. Today the led technique has developed much so it would be beneficial to change all the old lamps into energy saving metal-halide lamps. It is important to build the stadiums and fields so that there can be natural light as much as possible. (FIFA, 2015)

In the locker rooms and hallways a movement sensor is an environmental solution so that the light won't be on when there is nobody using the space.

3.9 Irrigation

It is estimated that grass field used to play a pro league needs about 20 000 litres of water for irrigation daily. The amount depends of course what's the weather conditions like. The irrigation is a bigger problem in southern hemisphere where there is a lack drinking water and then the football fields are irrigated heavily. It would be possible to catch the rainwater and use it for irrigation but it does not help the dry countries. Also the treated waste water could be one possible solution for irrigation. In the newest rain water can be collected. After it is treated onsite it can be storage and used for irrigation. (FIFA, 2015)

It is not only water resources irrigation is using. Energy is also needed to pump the water to the irrigation system.

4 Carbon footprint

It is quite difficult to compare the carbon footprint between the artificial turf field and natural grass field. We can expect the carbon footprint to be approximately the same in all the artificial turf fields. Things that affect to the footprint are for example the making of the materials, transport and usage of recycled materials.

The carbon footprint of natural grass fields are varying more due to climate- and weather conditions. Things affecting to the carbon footprint are, the amount of water needed to irrigate the grass, chemicals and fertilizers used in the field, exhaust fumes when cutting the grass and transport. On the other hand natural grass field can work as a small carbon sink because of the photosynthesis which artificial turf field cannot do. Some researchers think that because of the maintenance of natural grass field it causes more carbon dioxide what it can uptake. (Department of Sports and Recreation, 2011) The maintenance of artificial turf field is also done with machinery using fossil fuels so it is not carbon free either. (Department of Sports and Recreation, 2011 p.49)

The carbon footprint in Brazil world cup 2014 was according to FIFA, 2015, 2.7 million tonnes. That is about 1 million tonnes less than in the previous world cup in South Africa 2010. According to FIFA about 60% of the total carbon emissions of the world cups come from transportation.

Some of the top football clubs in the world are trying to compensate their carbon footprints by planting trees.

5 Winter usage

Most of the artificial grass fields in Finland are heated and the commonly used method is district heating. The costs to build a brand new heated artificial turf field are about 500 000- 1 000 000 euros. The costs depend of course of the facilities build around the field, for example locker rooms, stands and the size of them. Because of the big investment involved the utilization rate are tried to be held as high as possible. An average natural grass field has a utilization rate of about 20 weeks, ~240h/year, (April-September) and that rate is highly impacted of the weather conditions. During and after heavy raining the natural grass field has to dry before the usage, otherwise the surface gets really uneven

quickly. The artificial turf fields which does not have any heating systems has a utilization rate of around 45 weeks, 2250h/year. The heated artificial turf field has theoretical a utilization rate of 52 weeks, ~2600h/year, (year around) but of course in Finland where the winters can be really cold and there could be a lot of snow the utilization rate is not that high. The energy costs rises too high and it is not healthy to do sports in colder than -10 degrees. The winters are though getting milder, at least in the southern parts of Finland, which can increase the utilization rate. The heating power in a football field should be 120-250W per m². The requirement of the heating power is approx. 800kW.

Sodium chloride can also be used for de-icing in artificial turf fields which does not have heating system. The problems with the sodium chloride are that it cannot be used in really cold temperatures. The ideal temperature for sodium chloride is 0- -8 degrees. It is difficult to get the whole field evenly unfrozen if only using sodium chloride and some people might get some health issues or allergic reactions from the sodium chloride. It also might have some effects to the environment. Sodium chloride is also corroding the metal structures.

6 Environment and health

The effects of the artificial turf fields has been researched and quite often they are pointing at the higher risk for injury when playing on artificial turf. The natural grass is almost always softer and flexible than artificial one. As a surface the artificial turf field is harder and faster (meaning the speed of the football moving around) compared to natural grass which predispose to twists to ligaments and higher pressure for joints. Especially the ankles, knees and lower back are more likely to get injured. Also the football shoes get stuck sometimes to the artificial grass in fast turns which contributes to the twist injuries.

In sliding tackles, where the player is gliding along the surface on top of his legs, the artificial turf field is burning the top layer of the skin where the chemicals can permeate to the body.

There is a large group of people who are worried about the possible health impacts from the artificial turf fields. (YLE, 2017) There is a large amount of chemicals and toxic compounds for humans in the artificial grass and especially in the rubber granules. There are some researches about the topic and more researches are coming all the time.

Especially the recycled SBR-rubber granules are claimed to cause health problems. Sure, there can be found also researches which are telling that playing in the artificial grass is not causing any health problems to the players.

The biggest health risks for players are caused the recycled car tyres which are made for small rubber granules (SBR-rubber granules). They are containing for example PAH-compounds which are carcinogenic and causing hormone changes. The compounds are transferring to players through respiratory tract, especially when the artificial turf is inside a hall, and also through skin. The artificial turf field causes specially respiration problems when used in indoor spaces. The granules are dusting and especially after the field has been brushed the air in the indoor space tends to be quite poor. It can be improved with proper ventilation (Terveyden ja hyvinvoinnin laitos, 2015)

Especially lymphoma and leukaemia are been raised to be the most popular cancer types caused by the SBR- rubber granules. Particularly goalkeepers are reported to get leukaemia. The skin contact is constant because of jumping onto the field and the contact is on the large area of the body; arms, legs and face are often touched to the field. Also goalkeepers have a higher risk to get those rubber granules into the body through mouth, eyes and ears. (Environmental and health risks of rubber infill, 2007)

7 Environmental management in football

As football is the worlds' most popular sport that means that there are huge stadiums where football is played. Worlds' biggest stadium is called Rungrado May Day Stadium and it is located in the North Korea. It has a seating capacity for over 110.000 people. There are 24 stadiums that have a seating capacity of 80.000 seats or more. Those big stadiums are often located in the southern, sunny countries and some of them have solar panels on the exterior walls of the stadiums. The world championship is played every fourth year and it is one of the biggest sports events in the world. The tournament is played in several stadiums around the country. For example the coming FIFA world cup played in Russia in 2018 is played in 11 different stadiums around Russia. Some of the stadiums do exist already but some are specially made for this event. That gives a good opportunity to focus also the environmental aspects already in the building face. It is easier to do environmental solutions to a stadium which is in the planning face compared to a stadium already existing. Sure it is possible to improve the environmental friendliness of the old

stadiums but when building a new infrastructure the solutions can be made with smaller costs. (FIFA, 2015)

When organising games or tournaments in stadiums this big there are also some environmental aspects which need to be taken into consideration. Events such big as FIFA world cup is also a good stage to show new environmental technology and solutions to a big audience. It can also affect the thinking of young people and kids.

The biggest environmental aspect in events that big is waste management, recycling and re-usage of the materials. The less material ends up to the landfill the better. This is really important especially in the poor countries where the waste management is not that advanced and majority of the trashes ends up to the landfill.

When there are 100.000 people packed in a stadium there is going to be a lot of waste when they are eating and drinking. It is important to provide a possibility to sort out the trashes, for example plastic beer cups and water bottles, aluminium cans, glass, paper and cardboard cups, plastic wraps and bio waste. It is also important to encourage and guide the people to use the possibility to sort the trashes. Another thing which is important is to minimize the waste amount as little as possible for example trying to avoid separate packaging and plastic packages and bags. The cooking oil from the stadiums restaurants can be recycled into bio-diesel. Avoiding the trashes is of course the most efficiently way of waste management and usually the most economical also. In events this big even the smallest things can make a big difference. It is not only people coming to see football who should recycle and pay attentions to waste management, also the service providers such as the restaurateurs and catering services in the stadium should pay attention to the waste management and have some sort of plan how to minimize the amount of waste generated by them and by their customers.

Waste is also generated by the maintenance of the stadiums as well as the players and teams. It would be important that the waste management plan has taken into consideration the locker rooms recycling possibilities. It does not have to be that advanced, for example plastic container, bio waste container and mixed waste container would be enough in a locker room. There should be a possibility for the mechanics working in the stadium to compost the mowed grass and to separate all the chemicals, oils and fuels to a hazardous waste.

The waste water treatment is another important thing in such big events. Usually the waste water goes to the municipally system but in poor countries the systems are not necessary that efficient so it is one thing to pay attention to. Dual flush toilets are an environmental friendly solution and already really common today. Blow-dryers instead of tissue paper in the toilets next to the sinks reduce the waste significantly.

The big stadiums are for the most natural grass which means that the irrigation is quite heavy when the surface needs to be in a top condition all the time. Many of the stadiums do not have any roof so that the sun can easily burn the grass. Problems with the heavy irrigation highlighted in the poor and dry countries. The new technique provides a possibility to collect rainwater and treat it on site. The rainwater can be storage in tanks and use for irrigation. It does not cover the whole amount needed for irrigation.

There are solar panels installed into some of the stadiums which is a good thing and makes the stadium more self-sufficient. Now days the lights are energy efficient led lamps but there are many lamps and they needs to be bright so the solar panels provides an environmental friendly solution. It would be possible to install also wind turbines to the stadiums. Some stadiums with a environmental plan are using both solar panels and wind turbines to create energy of their own. (FIFA 2015)

The traffic connections need to be taken into consideration when planning events this big. The more people can get to the stadium with public transport the better. It is important in already in the planning face of stadiums to take the traffic connections into consideration. If the stadium is easy access with subway, train or bus the public will more likely to choose one of them.

It is actually the fans and public which creates the biggest amount of both carbon emissions and waste in football.

8 SWOT-analysis

Artificial turf field

Natural grass field

<p><u>Strengths</u></p> <ul style="list-style-type: none"> - durable - can be used for different sports - standardized, good quality - long operating hours - commonly liked - easy to maintain - cheapest operating hours 	<p><u>Weakness</u></p> <ul style="list-style-type: none"> - health issues - needs to be changed in every ~10 years - heathens in the sun - twist injuries - burn marks - stains - ball movement sometimes unnatural 	<p><u>Strengths</u></p> <ul style="list-style-type: none"> - natural material - throws can be practiced - photosynthesis - soft, easier for body movement - natural ball - atmosphere 	<p><u>Weakness</u></p> <ul style="list-style-type: none"> - sensitive to weather conditions - short operating hours - allergies - maintenance - fertilizers - irrigation in dry countries
<p><u>Opportunities</u></p> <ul style="list-style-type: none"> - dry countries - Nordic countries can use year around when heating system installed - development of the materials 	<p><u>Threats</u></p> <ul style="list-style-type: none"> - health concerns - higher risk for cancers - injuries 	<p><u>Opportunities</u></p> <ul style="list-style-type: none"> - new grass varieties which are more durable - rising temperatures in northern hemisphere 	<p><u>Threats</u></p> <ul style="list-style-type: none"> - rising temperatures in the warmer parts of the world - artificial turf fields

There are several strengths which speaks for the usage of the artificial turf field instead of the natural grass. Most important ones are the facts that the field is durable and can hold long operating hours with just a little maintenance. The maintenance is weekly and consists of the brushing of the field and picking up trashes and all the decomposable materials. The pile threads needs to be up and fluffy and the rubber granules needs to be evenly outspread,

especially in the area close to the goals and corners. If the field is in usage during winter times and it does not have a heating system it need to be ploughed after snowfalls and after ploughing some chemicals and sodium chloride needs to be spread to the field to keep the snow melted. The artificial turf is also really durable and can hold most of the bad weather conditions without them affecting to the surface, which is also related to the longer operative hours. The surface can be used to different kind of sports and usually schools and kindergartens are allowed to use them, they are usually forbidden to use the natural grass fields. FIFA has a standard for the artificial turf field so the 3rd generation artificial turf fields are really good to play around the world. In Finland the highest football league has a program that every artificial turf field where the league is going to be played needs to pass a yearly test. The game features are really close to the natural grass and that is one reason the artificial turf field are being more and more commonly liked. When the conditions of the fields are the same it is much easier and better for the players. For example the natural grass fields vary a lot field by field. So when playing in guest court you are never sure in what condition the grass field is.

The biggest weakness for the artificial turf field is the risks for health issues which have received quite much attention in the last couple of years. Also the risk for twist injuries has been in the players' consciousness several years and the burn marks from the artificial turf field belongs to football players everyday life. The burns are not that severe injury but there is a possibility that the burned skin let through the chemicals easily to the body. The rubber granules colours shoes, gloves and balls black and during winter the sodium chloride leaves white stains to clothes. During the warm summer months the artificial turf field heathens easily in sunny conditions because it absorbs the sunlight so it is rough to play there compared to natural grass field which reflects the sunlight much more. During heavy rain when the field cannot absorb the water the ball movement becomes unnatural which affects to the game. Today the biggest sports brands have brought to the market footballs that are specially made to artificial turf field.

The artificial turf field is thought to be maintenance free but the field needs weekly and monthly maintenance. One bigger maintenance task is to change the pile thread and fabric of the field in every 8-10 years depending on the operating hours. The old materials can be used in for example kids' playgrounds of school fields but they are not qualified to play football anymore, at least any competitive football. If an artificial turf field is in a competitive usage and it has high operating hours the surface needs to be changed already

after 5-6 years of usage, even though a regular maintenance. Artificial turf fields used in junior football lasts longer.

The biggest opportunity is the year around usage of the artificial turf field when the heating system is installed. The amount of football players keeps rising all the time so there is a growing demand for the training grounds, especially during winter. The artificial turf field is a good option also in the southern hemisphere where the drought can last long. When no irrigation needed the field can be used even though in dry conditions. The field tolerates monsoon rain much better than natural grass so it would be a good option in countries where the monsoon exists. The materials develop all the time so that gives opportunities too. For example in the Netherlands some of the artificial turf fields' rubber granules have been changed to natural rubber granules to avoid the health issues. The usage of natural rubber granules is still more expensive than the SBR-granules but when the materials develop perhaps the material costs becomes cheaper and it is economical to choose the environmental- and health friendly options.

The threats of the artificial turf fields are the risks related to human health and injuries. The raised risk for carcinogenic, endocrine disruptive effects and respiration problems are the biggest. Injuries which happen in the artificial turf fields are usually temporary and treatable but the health issues can affect ones whole life and shorten the life expectancy.

Natural grass fields' biggest strength is the fact that it is a natural material. Therefore it is easier and natural also for the body to take the pressure from playing. The ball movement is natural and easy to read and anticipate. The natural grass fields are also commonly used to track and field and good thing about the grass is that the throws can be practiced also on the same field. The grass can work as a carbon sink and it can absorb some water during heavy rains. And of course many football players think that the natural grass is the only real surface to play football in. All the biggest leagues in the world use still natural grass as the surface. The natural grass, like all other plants, photosynthesizes which can be counted as strength.

The biggest weakness of the natural grass is especially in the northern hemisphere, but also elsewhere, the short operating hours. The winter time shortens the operating hours here in north but the grass cannot tolerate that much of training/ games per day. It need to rest more than what it can be used. And the operating hours are much depending on the weather conditions also. The surface is really sensitive to weather conditions, when it is hot and sunny it need a lot of irrigation and then when it is raining the grass cannot tolerate

football. The field gets so soft that it becomes slippery for the players and it get really fast into a bad condition. And in warmer countries the irrigation needs to be done daily which can consume already poor water storages. It is estimated that a natural grass field used in a top league needs about 10 000- 20 000 litres of water to irrigation every day. (FIFA, 2015) The grass field needs quite much maintenance also. Depending on the weather the grass needs to be mowed approx. twice a week. Irrigation is also needed as well as the usage of fertilizers and drawing the chalk lines regularly. Some people might get allergies from different grass arts.

The opportunities for natural grass fields are the development of new grass varieties' which would be more durable than the varieties used today. The rising temperatures could make the grass season longer in the northern hemisphere if the weather would get warmer but not rainier.

Threats are especially in the southern parts of the world the rising temperatures which demand more irrigation. Also the growing popularity of artificial turf fields is a threat for natural grass fields. The quality and durability gets better so they become more popular. Also the common opinion amongst athletics about the artificial turf field is getting more positive. (Suomen riskienhallintayhdistys, 2012)

9 Discussion

This subject should be looked critically. Those who are against the artificial turf fields they find out all the negative sides of the field but forget the good sides and of course vice versa. There are always pros and cons in every situation but usually we look at the thing we like to look and tend to forget the other side of the coin.

Fields used to trainings and kids games does not have that big of an environmental impact. When comparing to big stadiums the environmental impacts multiplies. The main reason for the environmental issues of football stadiums are the amount of people they can take. It is quite obvious that 80 000- 100 000 people creates tons of waste and consumes a lot of energy. If one wants to know the accurate environmental impact of a field it should calculate all the things affecting environment and then make a proportion how many hours of usage the field has. For example those big stadiums have very short operating hours. The home team only plays games there and most of the teams have a separate training field for everyday trainings. When knowing the amount of waste and carbon the big stadiums creates, we can assume that they are the ones making the biggest environmental impact.

The universal comparison of these to field type is also difficult because of the different climates. When comparing those two field types the fields should be located close to each other to get a relevant result. Even in a country like Finland the weather conditions varies a lot. When in March there is still a full winter in the northern Finland in southern part the snow might have melted away already. So the outdoor season is much longer in southern Finland than it is in the northern Finland. That is a reason why it is difficult to compare fields even inside a one country. The same goes in countries where there are for example mountains and lowlands and the weather conditions vary a lot.

When talking about the health issues the rubber granules can cause the discussion is forgetting all the health benefits that the sports are causing. Today there are many carcinogenic compounds in our everyday life. It is sure difficult to compare the health benefits and health issues but the number of players is so high and the amount of people getting sick from the artificial turf field is still quite marginal. Also often the reason to get sick might be a cause of several different things together, not only one. Like in this case the SBR-rubber granules.

Even though FIFA has standardized the artificial turf fields it does not take into consideration the environmental aspects. The FIFA star- program is all about the game features and ball movement on the field. The environmental aspect should be included to the standardization. Many fields around the world are built up according to the FIFA Star-program so if the environmental aspects are included to the program they would be taken into consideration automatically. This would be extra important in poor countries where the environment is not necessary the first thing in mind when building new fields.

The tests are done yearly so if environment would be included to the Star-program then the environmental issues would also be checked yearly and if there is something to needs to be done it would be noticed.

Writing this work was quite demanding. The subject itself was interesting but it was hard to write when I as a football player have opinions about the topic which are based on only to my own experiences and feelings. They are based on the game features, feelings in the body (like burn marks and scars after falling) and the opinion is also mixed in the overall feelings about football. Other thing which made the comparison of the two field types difficult was the differences between fields. Meaning that it is demanding to compare the environmental affects between a field somewhere in a city in Finland which is used to trainings and games and as a comparison a stadium where only representative team plays

and possibly trains but otherwise the field is unused or it is used for other purposes such as music concerts.

It might have been a good idea to divide this into separate chapters for regular fields and then the stadiums because of the big differences in them.

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